LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA12 | Waddesdon and Quainton

Flood risk assessment (WR-003-012)

Water resources

November 2013

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Department for Transport

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1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

1.1.1 The water resources and flood risk assessment appendices comprise three parts. The first of these is a route-wide appendix (Volume 5: Appendix WR-001-000).

1.1.2 Specific appendices for each community forum area (CFA) are also provided. For the Waddesdon and Quainton area (CFA12), these are:

- a water resources assessment (Volume 5: Appendix WR-002-012); and
- a flood risk assessment (i.e. this appendix).

1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.

1.2 Scope and structure of this assessment

1.2.1 This flood risk assessment (FRA) considers the assessment of flood risk in CFA12. The assessment has been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF)[1] which aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, it is safe without increasing flood risk elsewhere.

1.2.2 The FRA methodology and a review of the relevant local planning policy documents are provided in Section 2 of this report. The design criteria are provided in Section 3 and Section 4 documents the sources of information that have been reviewed. Section 5 provides a description of the planned works within CFA12. Section 6 considers baseline flood risk and the risk of flooding to the Proposed Scheme from all relevant sources. Flood risk mitigation measures included within the Proposed Scheme are detailed in Section 7. The effect of the Proposed Scheme on the risk of flooding is considered in Section 8.

1.3 Location

1.3.1 CFA12 covers approximately 10km of the Proposed Scheme in Aylesbury Vale District, from just south of the A41 Bicester Road, near Fleet Marston to the north-west corner of Sheephouse Wood, south-west of Calvert. The area includes the district wards of Waddesdon, Quainton, Grendon Underwood, Steeple Claydon and Marsh Gibbon. It extends from the parish of Waddesdon in the south-east, across Quainton and Grendon Underwood parishes to Calvert Green parish in the north-west.

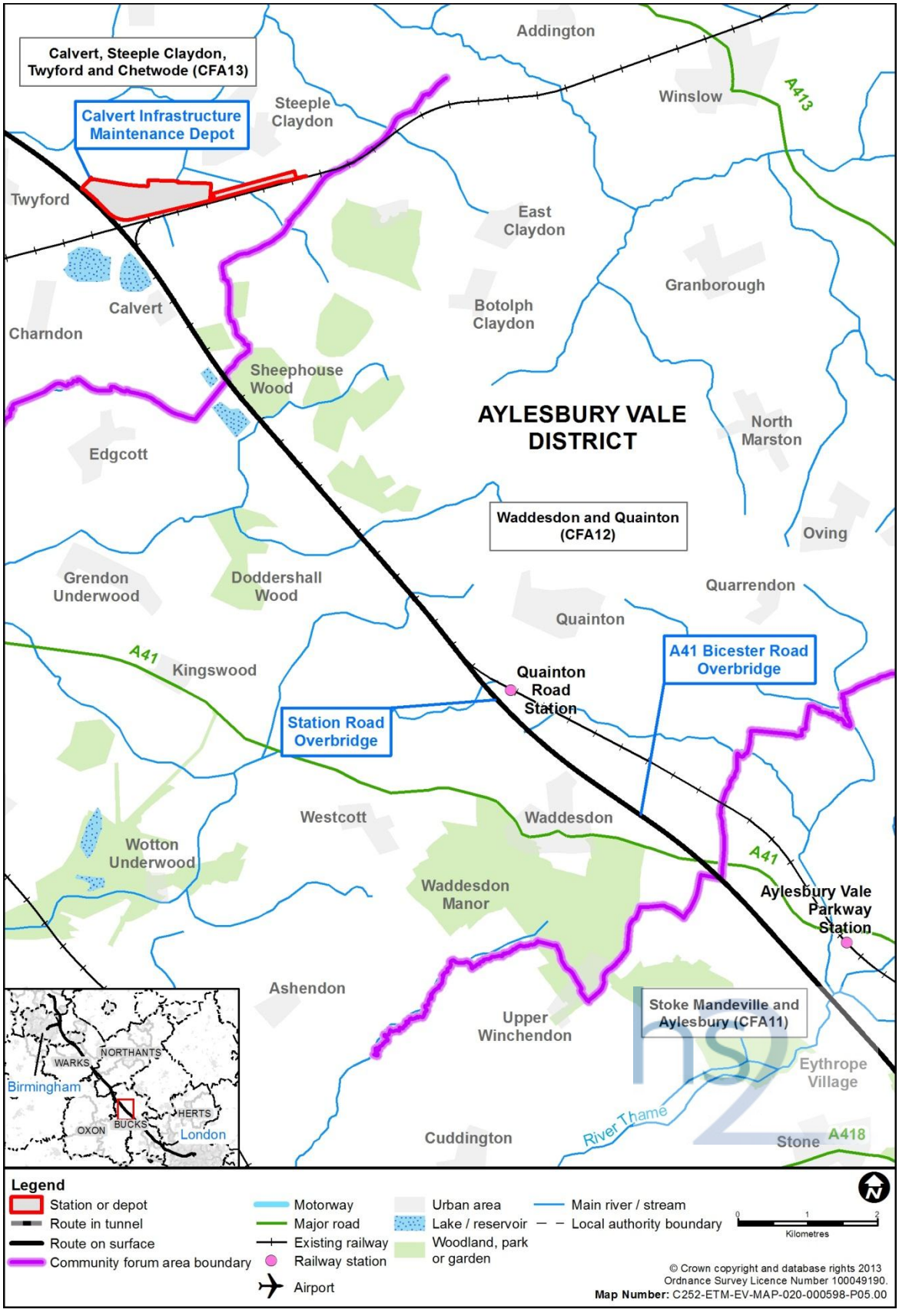
[1] Department for Communities and Local Government (2012), *National Planning Policy Framework*.

1.3.2 The Stoke Mandeville and Aylesbury area (CFA 11) is located to the south and the Calvert, Steeple Claydon, Twyford and Chetwode area (CFA 13) is to the north, as shown on Figure 1.

1.3.3 The route will cross a number of primary watercourses in CFA12 as identified using the surface water crossing (SWC) references on Map WR-01-016 and Map WR-01-017 (Volume 5, Water Resources and Flood Risk Assessment Map Book) including:

- tributaries of the Fleet Marston Brook (SWC-CFA12-01) which is a tributary of the River Thame;
- the River Ray (SWC-CFA12-09) and its tributaries the Tetchwick Brook (SWC-CFA12-02 and SWC-CFA12-03), the Doddershall Brook (SWC-CFA12-07), and the Lee Wood Farm Ditch (SWC-CFA12-10); and
- the Muxwell Brook (SWC-CFA12-11 and SWC-CFA12-12).

Figure 1: Waddesdon and Quainton area



2 Flood risk assessment methodology

2.1 Source-pathway-receptor model

2.1.1 Flood risk is assessed using the source-pathway-receptor model. In this model individual sources of flooding within the study area are identified. The primary source of flooding is rainfall, which is a direct source in the short-term (surface water flooding) and can lead to flooding from watercourses (river flooding) and overloaded man-made collection systems (sewer flooding) in the short- or medium-term. Stored rainfall, either naturally in below ground aquifers and natural lakes or artificially in impounded reservoirs and canals can lead to flooding when the storage capacity of the system is exceeded. A final source of flooding arises from tidal effects and storm surges caused by low pressure systems over the sea.

2.1.2 For there to be a risk of flooding at an individual receptor there must be a pathway linking it to the source of flooding. The pathways within the study area are assessed by reviewing national datasets that show the spatial distribution of flood risk. The associated risk magnitude is then categorised.

2.1.3 Receptors considered in this assessment include the Proposed Scheme and existing development within 1km of the Proposed Scheme. The Proposed Scheme includes all associated permanent infrastructure. Areas of interest are identified through comparison of the national spatial datasets with the design drawings. Where a risk is identified mitigation is proposed in line with recommendations in the NPPF.

2.1.4 Existing receptors within the study area are identified using Ordnance Survey (OS) mapping information. A high-level screening assessment is then undertaken to identify receptors that are within or in close proximity to an area of flood risk via pathways indicated using the flood risk data sources listed below. The vulnerability of each receptor is classified using Table 2 of the NPPF Technical Guidance Document[2].

2.1.5 The assessment then considers the vulnerability of the receptor with reference to the flood risk category of the source using Table 3 of the NPPF Technical Guidance Document and assesses whether the Proposed Scheme has any potential to influence or alter the risk of flooding to each receptor. Where such potential has been identified, mitigation is proposed based on further analysis.

2.2 Flood risk categories

2.2.1 The level of flood risk is categorised by assessing the design elements against the datasets for each source. A matrix showing the flood risk category associated with each flooding source is presented in Table 1.

[2] Department for Communities and Local Government (2012), *National Planning Policy Framework Technical Guidance.*

Table 1: Flood risk category matrix for all flooding sources

Source of flooding	Flood risk category				
	No risk	**Low**	**Medium**	**High**	**Very high**
Rivers		Flood Zone 1	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Surface water	No surface water flooding.	Surface water flooding <0.3m for 1 in 200 years event.	Surface water flooding >0.3m for 1 in 200 years event; and Surface water flooding <0.3m for 1 in 30 years event.	Surface water flooding >0.3m for 1 in 30 years event.	
Groundwater		Very low-low	Moderate	High-very high	
Drainage and sewer systems	No sewer in vicinity of site.	Surcharge point >20m from site and no pathways.	Surcharge point within 20m of site and restricted pathways.	Sewer network crosses site and pathways exist.	
Artificial sources	Outside of inundation mapping/no pathway exists.	Within inundation mapping/ pathway exists.			

2.3 Regional and local flooding planning policy documents

2.3.1 The lead local flood authority (LLFA) for the study area is Buckinghamshire County Council (BuCC). The recommendations from the BuCC Preliminary Flood Risk Assessment (PFRA)[3], undertaken in accordance with the Flood Risk Regulations 2009[4], have been reviewed in carrying out this assessment. The draft BuCC Local Flood Risk Management Strategy (LFRMS)[5] is at the consultation stage and was published in February 2013. The local planning authority (LPA) for the study area is Aylesbury Vale District Council (AVDC). The AVDC Core Strategy (referred to as the Vale of Aylesbury Plan) is at consultation stage.

Buckinghamshire County Council Preliminary Flood Risk Assessment

2.3.2 The BuCC PFRA confirms that there are no indicative flood risk areas of national significance within the Buckinghamshire area. Consequently, only Stage 1 of the Flood Risk Regulations 2009 process (i.e. the PFRA) has been completed.

2.3.3 The BuCC PFRA recognises that the construction and engineering of the Proposed Scheme may have a significant impact upon surface water flows. For example

[3] Jacobs (2011), *Buckinghamshire County Council Preliminary Flood Risk Assessment.*
[4] *Flood Risk Regulations 2009* (SI 2009 No.3042). London, Her Majesty's Station Office.
[5] Buckinghamshire County Council (2013), *Buckinghamshire County Council Local Flood Risk Management Strategy 2013 - 2018.*

embankments and cuttings may, without suitable design solutions, impede the flow of small watercourses and surface runoff.

Buckinghamshire County Council Local Flood Risk Management Strategy

2.3.4 The BuCC LFRMS guides the planning process in relation to flood risk across all categories. The BuCC LFRMS outlines key policies in relation to development within the Buckinghamshire County. Of key concern is the management of future flood risk with a particular emphasis on the use of sustainable drainage systems (SuDS). Specific policies of relevance to the Proposed Scheme are:

- "Policy 6 – the LLFA will seek to reduce the risk of flooding now in a way which does not compromise the interconnected needs of the economy, society and environment in the future"; and
- "Policy 15 – SuDS should be used in new developments to reduce the rate and volume of surface water. Design of SuDS to meet national standards and to be adopted by the SuDS Approval Body. SuDS are expected to provide natural removal of pollutants and sediments, promote aquifer recharge, enhanced biodiversity, add aesthetic value and be easily maintainable."

Thames Region Catchment Flood Management Plan

2.3.5 All watercourses in this area fall within the Thames Region Catchment Flood Management Plan[6] (CFMP) which covers the extent of the Thames basin. The main focus of the plan revolves around the high risk of flooding to key urban centres that are primarily downstream of the study area. The Thames Region CFMP also considers the predicted future increase in flood risk due to climate change. Restoration of culverted watercourses is a high priority for the Aylesbury area. There is a high focus on managing and reducing existing flood risk in the basin through restoring and enhancing natural floodplain capacity and utilising the potential to manage floodwater through new developments, especially within the upstream tributaries. This is of particular relevance to the River Ray and Muxwell Brook where opportunities exist for at-source flood relief through natural floodplain enhancement.

Aylesbury Vale Water Cycle Strategy

2.3.6 The Aylesbury Vale Water Cycle Strategy[7] reviews flood risk management planning policy relevant to Aylesbury Vale and outlines location specific concerns regarding flood risk management. Significant risks of flooding are identified along the River Ray along with a relatively high susceptibility to groundwater flooding across the district: particularly in the Quainton, Waddesdon and Calvert Green parishes. All proposed developments in the Aylesbury Vale district will require detailed drainage strategies and SuDS proposals. Surface water should be discharged separately to ground or local watercourses without using existing public sewers.

[6] Environment Agency (2007), *Thames Region Catchment Flood Management Plan*
[7] Halcrow and AVDC (2012), *Aylesbury Vale Water Cycle Strategy*

Aylesbury Vale Strategic Flood Risk Assessment

2.3.7 The AVDC Level 1 Strategic Flood Risk Assessment (SFRA)[8] includes advice on planning policy within the development area and is often used as a basis for policy setting and planning decisions.

2.3.8 The AVDC SFRA identifies the need for surface water runoff management in the district due to particular concern over flood risk in the River Thame and Cherwell catchments of which the watercourses in the study area form a part.

2.3.9 Infiltration based SuDS are preferred as a means of surface water management, particularly to the south of Aylesbury and ground investigations are required to determine the feasibility of such techniques. In addition, opportunities are sought to enhance and supplement the existing flood storage and alleviation measures already in place for AVDC. Opportunities for source-controlled flood risk management are identified with the Stoke Brook and downstream Bear Brook catchments of particular priority. SFRA policy indicates that:

- management of surface runoff should use site specific and strategic SuDS measures encouraging source control where possible; and
- proposed infrastructure should avoid interference with floodplain flow and storage where they cross existing river valleys unless they are also specifically designed as part of the strategic flood risk management options. Consultation with the Environment Agency is essential in such cases.

Vale of Aylesbury Plan

2.3.10 The Vale of Aylesbury Plan[9] is in the consultation stage. Objective 7 which covers adaptation to and mitigation against climate change is of specific relevance to flood risk and development and covers the following points:

- no built greenfield development to take place in the functional floodplain and/or Flood Zones 2 or 3 other than for essential strategic infrastructure; and
- improved flood protection including more effective use of multi-functional green spaces which can assist in flood control.

2.3.11 Policy VS11 sets out the position of AVDC towards protection of environmental assets with a focus on maintaining watercourses and their settings for their biodiversity and recreational value. Policy VS11 also focuses on the incorporation of SuDS and flood storage areas to reduce downstream flood risk.

[8] Royal Haskoning and AVDC (2007), *Aylesbury Vale SFRA – Level 1 Report*
[9] AVDC (2013), *The Vale of Aylesbury Plan Strategy 2011 – 2031 Proposed Submission (2013)*

3 Design criteria

3.1.1 It is a requirement of the design that the Proposed Scheme shall be protected against flooding from any source during the 1 in 1,000 years return period (0.1% annual probability) rainfall event with water levels not rising closer than 1m to the top of rail level.

3.1.2 In accordance with the NPPF an allowance for climate change is included in the assessment by assuming that peak rainfall intensity will increase by 30% and that peak river flows will increase by 20%.

4 Data sources

4.1 Primary datasets

4.1.1 Consistent with the requirements of the NPPF this assessment considers the risk of flooding from rivers, direct surface water runoff, rising groundwater, overwhelmed drainage and sewer systems, and artificial sources such as reservoirs, lakes and canals.

4.1.2 The Proposed Scheme lies entirely outside the extent of flooding from the sea and therefore the risk of flooding from tidal sources is not considered in this assessment.

4.1.3 The primary datasets for each source of flooding used to assess the design elements are presented in Table 2. A high-level review of the risk of flooding and potential impacts is undertaken on the basis of these datasets across all flood sources. Where this review indicates potentially significant impacts on the risk of flooding or a risk of flooding to the route, further investigation in the form of hydraulic modelling is undertaken.

Table 2: Flood risk assessment data sources

Source of flooding	Datasets reviewed	Data owner
Rivers	Flood zone mapping. Detailed River Network. Catchment hydraulic models.	Environment Agency
Surface water	FMfSW. Local surface water flood mapping.	Environment Agency LLFA
Groundwater	Areas susceptible to groundwater flooding. 1:50,000 geological mapping (superficial and bedrock). Potential for elevated groundwater.	British Geological Survey (BGS) LLFA
Drainage and sewer systems	Sewer network plans. Lost river location plans.	Water companies (various) Local planning authority
Artificial sources	Reservoir inundation mapping (RIM). Canal infrastructure locations. Trunk water main asset plans.	Environment Agency Canal & River Trust Water companies (various)

4.2 Site familiarisation visits

4.2.1 A site familiarisation survey was undertaken in January 2013 to the River Ray and Muxwell Brook to visit the area of proposed works and associated tributary streams where access was granted.

5 The proposed development

5.1 Topography and land use

5.1.1 The land use character within the study area is predominantly mixed rural agriculture interspersed with isolated farmsteads and dwellings. The only settlement that falls within the study area is Waddesdon towards the south of the study area. The Proposed Scheme converges with the route of an existing single-track conventional line around 4km from the southern extent of the study area.

5.1.2 The topography of the study area is influenced in the south by the Midvale limestone ridge and in the north by the clay lowlands. Generally low-lying, the topography is observed to be gently undulating through a number of watershed stream valleys.

5.2 Local flood risk receptors

5.2.1 The vulnerability of each local receptor, with an identified pathway within the study area, is presented in Table 3. The vulnerability is classified in accordance with the recommendations of Table 2 in the NPPF Technical Guidance Document and the Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2).

Table 3: Vulnerability of local receptors in CFA12

Local receptor	Description	Vulnerability classification	Source/pathway
Lower Blackgrove Farm	Residential dwelling and agriculture	More vulnerable	Groundwater - very high
Waddesdon Village	Residential, commercial, police and fire stations	More vulnerable	Surface water 30 years - deep Overloaded sewers
Waddesdon Sewage Treatment Works	Sewage treatment works	Less vulnerable	Surface water 30 years - shallow
Little Manor Holding	Agriculture	Less vulnerable	Surface water 30 years - shallow
Buckinghamshire Railway Centre	Commercial leisure	Less vulnerable	Surface water 200 years - shallow
Doddershall House	Access road to historic and residential building	More vulnerable	Surface water 30 years - deep
Woodlands Farm	Access road to agricultural and residential dwellings	More vulnerable	River flooding Flood Zone 3 Surface water 30 years - shallow
Access road to Upper Greatmoor Farm and Lower Greatmoor Farm	Access road to agricultural and residential dwellings	More vulnerable	River flooding Flood Zone 3 Surface water 30 years - shallow

5.3 Description of the Proposed Scheme

5.3.1 The Proposed Scheme through the study area will be approximately 10km in length. It will commence just south of the A41 Bicester Road, near Fleet Marston, proceeding to the north-west. It will pass through the southern edge of Quainton, near the Buckinghamshire Railway Centre, and will then run parallel to the Aylesbury Link railway crossing over the River Ray and passing Finemere Wood. The route will exit the area at the north-west corner of Sheephouse Wood, to the south-east of Calvert as shown on Map CT-06-047 to Map CT-06-053 (Volume 2, CFA12 Map Book).

5.3.2 The Proposed Scheme will leave the Stoke Mandeville and Aylesbury area (CFA11) on an embankment, approximately 1.3km long and up to 3m high, and then continue past the existing A41 Bicester Road for approximately 600m. The route will then continue north-west in a cutting up to 14m deep for approximately 600m. The A41 Bicester Road will be realigned to the north of its present alignment for a length of approximately 1.3km. The realigned road will run parallel and to the north-east of the Proposed Scheme between Hunters Farm and Wayside Farm. It will then cross over the Proposed Scheme, which will be in cutting, on an overbridge and run south westwards to rejoin the existing A41 Bicester Road approximately 600m west of The Grand Lodge.

5.3.3 The route will continue north-west in a cutting for approximately 1km from the A41 Bicester Road overbridge through farmland east of Waddesdon to the Waddesdon sewage treatment works. Key features along this section of route are a pumping station, land drainage area and culvert immediately south of Footpath WAD/3 accommodation underbridge. The land drainage will discharge into an unnamed watercourse to the north-east of the Aylesbury Link railway and will require a 500m long drainage channel and culvert through the existing railway embankment.

5.3.4 The Proposed Scheme will continue north-west in a cutting, up to 5m deep for approximately 400m. It will then continue onto embankment, up to 3m high, for approximately 1.2km to the Station Road overbridge to the west of the Buckinghamshire Railway Centre at Quainton. The route will proceed into an approximately 550m long cutting, up to 3m deep, until it converges with the Aylesbury Link railway corridor. The two routes will then run parallel on an embankment up to 5m high and approximately 1.3km long.

5.3.5 The Proposed Scheme will continue to run parallel to the Aylesbury Link railway on its west side. The Proposed Scheme will be at approximately the same level as the Aylesbury Link, on a series of embankments and cuttings. It will cross the River Ray approximately 7m above existing ground level. At the northern end of the section the route will run between the Calvert Landfill site, to the west, and Sheephouse Wood, to the east, for approximately 800m.

6 Existing flood risk

6.1 Historical flooding incidents

6.1.1 The AVDC SFRA identifies specific historical flooding events within the study area arising from the Fleet Marston Brook to the north of Waddesdon. The BuCC PFRA does not identify any incidents of historic flooding from non-river sources within the study area.

6.2 Risk of flooding from rivers

6.2.1 Within the study area, the Proposed Scheme will cross the floodplains of the River Ray (SWC-CFA12-09) and the Muxwell Brook (SWC-CFA12-12) tributaries of the River Cherwell - see Map WR-01-016 and Map WR-01-017 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

6.2.2 In addition, the Proposed Scheme will cross four minor watercourses which are defined within the Environment Agency river network but do not have associated flood zones: the Fleet Marston (SWC-CFA12-01), Tetchwick (SWC-CFA12-02), and Doddershall (SWC-CFA12-06) Brooks and the Lee Wood Farm Ditch (SWC-CFA12-10), a tributary of the Muxwell Brook. These watercourses are assessed within the risk of flooding from surface water section (Section 6.3).

River Ray

6.2.3 The River Ray has a catchment size of approximately 5km^2 at the intersection with the Proposed Scheme resulting in an estimated 1 in 100 years return period (1% annual probability) peak flood flow of approximately 5m^3/s (calculated using the Revitalised Flood Hydrograph (ReFH) rainfall-runoff methodology). The route will occupy approximately 2,600m^2 of Flood Zone 3 and 2,900m^2 of Flood Zone 2.

6.2.4 The Adam's embankment design element lies within the area at risk of flooding from the River Ray as shown on Map CT-06-052 (Volume 2, CFA12 Map Book).

Flood risk to Proposed Scheme

6.2.5 A comparison of the outline of each flood zone with light detection and ranging (LiDAR) for this crossing suggests a 1 in 100 years return period (1% annual probability) flood water level of approximately 82m above Ordnance Datum (AOD), and a 1 in 1,000 years return period (0.1% annual probability) flood water level of approximately 82.5m AOD. The ground level of the floodplain is approximately 80-81m AOD.

6.2.6 The minimum top of rail level at the crossing will be 86.5m AOD, at least 4m above the estimated 1 in 1,000 years return period (0.1% annual probability) flood water level. As a result, the risk of flooding to the route will be less than 0.1% (low risk). There are no other elements to the Proposed Scheme that will potentially be at risk of flooding.

Muxwell Brook

6.2.7 The Muxwell Brook has a catchment size of approximately 4km^2 at the intersection with the Proposed Scheme resulting in an estimated 1 in 100 years return period (1% annual probability) peak flood flow of approximately 5m^3/s (calculated using the ReFH rainfall runoff methodology). The base of the natural valley crosses the Proposed Scheme around 100m south of the culvert conveying the watercourse suggesting that the Muxwell Brook channel, which flows along the southern boundary of Sheephouse Wood, has historically been diverted away from its natural course. During the site walkover survey of the area out-of-channel flow was observed along the base of the natural valley discharging via the existing underbridge and adjacent culvert. The existing access underbridge was flooded with standing water. Although the survey was undertaken during the winter months there had been no exceptional rainfall events in the recent past. In addition, silt deposits and vegetation damage observed within the valley suggested that more significant flooding of the valley had recently been experienced. Therefore, the access underbridge may experience flooding on a relatively frequent basis.

6.2.8 In association with the mineral extraction works at the Calvert site the Muxwell Brook has been subject to a significant diversion downstream of the Proposed Scheme (to the west side). Known as the Mega Ditch the diverted channel runs south alongside the existing railway for approximately 700m to Upper Greatmoor Farm before turning perpendicular away from the route to the south. The channel is understood to carry the full flow of the Muxwell Brook around the perimeter of the site returning to the natural channel at the Edgcott to Shipton Lee Road. According to the Muxwell Brook Reinstatement and Realignment report[10] the channel was designed with sufficient capacity to fully convey the 1 in 100 years return period (1% annual probability) flood flow. Following restoration works for the Greatmoor Energy from Waste (EfW) Plant the Mega Ditch will continue to serve as a flood relief channel carrying approximately 40% of baseflow at all times and the majority of the flow during flood events with a 1 in 20 years return period (5% annual probability) or greater.

6.2.9 The route will occupy approximately 830m^2 of both Flood Zone 3 and of Flood Zone 2 at the valley crossing. Design elements that lie within the area at risk of flooding from the Muxwell Brook are the Grendon Underwood embankments (No.1 and No.2) and Footpath CAG/2 underbridge as shown on Map CT-06-053 (Volume 2, CFA12 Map Book).

6.2.10 The existing Footpath CAG/2/1 will be diverted from north of the Proposed Scheme through the Footpath CAG/2 underbridge and extended to connect to Bridleway CAG/3/1.

Flood risk to Proposed Scheme

6.2.11 A comparison of the outline of each flood zone with LiDAR for this crossing suggest a 1 in 100 years return period (1% annual probability) flood water level of no more than 76m AOD. The ground level of the floodplain is approximately 74-75m AOD.

[10] FCC Environment Ltd (2012), *Muxwell Brook Reinstatement and Realignment Report*

6.2.12 The minimum top of rail level at the crossing will be 79.1m AOD at least 3m above an estimated 1 in 1,000 years return period (0.1% annual probability) flood water level. As a result, the risk of flooding to the rail elements of the Proposed Scheme will be less than 0.1% (low risk).

6.2.13 Ground levels will be lowered to accommodate the Footpath CAG/2 underbridge beneath the Proposed Scheme. The underbridge is currently located at the base of the natural valley of the Muxwell Brook which has been observed to flood. Ground levels at the proposed underbridge will be up to 800mm below current ground levels at the same location with minimum ground levels of 74.1m AOD. The access through the underbridge will be flooded to depths up to 2m in the 1 in 1,000 years return period (0.1% annual probability) flood event. According to the Department for Environment, Food and Rural Affairs (Defra) guidance on flood hazard[11, 12] depths of 2m result in a hazard rating within the underpass of up to 2.0, 'danger for most' during extreme flood events.

6.3 Risk of flooding from surface water

Cranwell Farm

6.3.1 As the Proposed Scheme enters the study area it will cross an area shown on the Environment Agency's Flood Map for Surface Water (FMfSW) to be at risk of shallow (between 0.1m and 0.3m in depth) flooding from direct surface water runoff during both the 1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall events. The area is associated with a well-defined dry valley that runs parallel to the A41 Bicester Road from west to east towards the Fleet Marston Brook. The Bicester Road embankment lies within the area shown to be at risk of surface water flooding.

6.3.2 The Bicester Road embankment, as shown on Map CT-06-047 (Volume 2, CFA12 Map Book), will be a minimum of 2.3m above existing ground levels through the area at risk of flooding and therefore no less than 2m above potential maximum flood levels in the 1 in 200 years return period (0.5% annual probability) rainfall event (no risk).

Wayside Farm dry valley

6.3.3 To the east of Wayside Farm the Proposed Scheme will cross an area shown on the FMfSW to be at risk of shallow flooding from direct surface water runoff during the 1 in 200 years return period (0.5% annual probability) rainfall event. The area at risk runs along a field boundary and, although disconnected from downstream areas at risk of flooding, is associated with a dry valley that flows in a north-easterly direction towards the Fleet Marston Brook. The design elements that lie within the area at risk of flooding are the Waddesdon South cutting and realigned A41 Bicester Road as shown on Map CT-06-048 (Volume 2, CFA12 Map Book).

6.3.4 The Proposed Scheme will be in cutting at the valley crossing. The ground level is approximately 81m AOD. The top of rail level at the valley crossing will be 83.1m AOD,

[11] Environment Agency (May 2008), *Supplementary note on flood hazard ratings and thresholds for development planning and control purpose – clarification of the Table 13.1 of FD/2320/TR2 and Figure 3.2 of FD2321/TR1*
[12] Environment Agency and DEFRA (2006), *R&D Outputs: Flood Risks to People Phase 2 FD2321/TR2 Guidance Document.*

nearly 10m below current ground levels. Comparison of the FMfSW outlines with ground levels suggests a 1 in 200 years return period (0.5% annual probability) flood level of approximately 94m AOD. Given the localised and disconnected nature of the surface water flood extent, flows are expected to be low and will be absorbed into the land drainage for the Proposed Scheme.

Briar Hill Farm dry valley

6.3.5 To the east of Briar Hill Farm the Proposed Scheme will cross an area shown on the FMfSW to be at risk of shallow flooding from direct surface water runoff during the 1 in 200 years return period (0.5% annual probability) rainfall event. The area at risk runs along a field boundary and is associated with a narrow dry valley that flows in a north-easterly direction towards the Fleet Marston Brook. The design elements that lie within the area at risk of flooding are the Waddesdon South cutting and the realigned Blackgrove Road, as shown on Map CT-06-048 (Volume 2, CFA12 Map Book).

6.3.6 The Proposed Scheme will be in cutting at the valley crossing. The ground level is approximately 93m AOD. The top of rail level at the valley crossing will be 83.1m AOD, nearly 10m below current ground levels. Comparison of the FMfSW outlines with ground levels suggests a 1 in 200 years return period (0.5% annual probability) flood level of approximately 94m AOD. There will therefore be a risk of flooding to the Proposed Scheme. Ground level information suggests that Briar Hill Farm is situated on the watershed between two catchments and the contributing catchment area for the dry valley, measured using LiDAR information, is approximately 0.1km^2. Surface water flows in flood conditions will therefore be low and will be absorbed into the land drainage for the Proposed Scheme. The realigned Blackgrove Road will be on embankment and will therefore be elevated above the risk of surface water flooding.

Glebe Farm dry valley

6.3.7 Where the Proposed Scheme will cross a valley near to Glebe Farm, the FMfSW shows a 200m wide area at risk of shallow flooding from direct surface water runoff during the 1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall events. Comparison of the FMfSW outlines with ground levels suggests a 1 in 200 years return period (0.5% annual probability) flood level of no more than 83m AOD. Design elements that fall within the area at risk of flooding are Waddesdon embankment and Glebe Farm Public Right of Way (PRoW) underbridge as shown on Map CT-06-049 (Volume 2, CFA12 Map Book).

6.3.8 The minimum top of rail level within the area at risk will be 85.3m AOD with an embankment height through the area of no less than 4.9m. There will be a freeboard of at least 2.3m for the minimum top of rail level at the valley crossing over the 1 in 200 years return period (0.5% annual probability) surface water flood water level (no risk).

6.3.9 The Footpath WAD/3 accommodation underbridge will be below existing ground levels beneath the Proposed Scheme. The proposed underbridge will be located directly at the base of the dry valley and will therefore potentially be at risk of flooding. Surface water, however, will be intercepted by the Proposed Scheme land

drainage and discharged to a balancing pond before being conveyed beneath the route to a drainage ditch downstream. In addition, pumps will be provided to remove any ponded surface water in the subway to a balancing pond.

Fleet Marston Brook

6.3.10 Where the Proposed Scheme will cross the Fleet Marston Brook (SWC-CFA12-01), the FMfSW shows a narrow band along the valley bottom to be at risk of shallow flooding from direct runoff during the 1 in 200 years return period (0.5% annual probability) rainfall event. Design elements that fall within the area at risk of flooding are Waddesdon north cutting (on embankment at the area of risk) and Quainton south embankment as shown on Map CT-06-049 (Volume 2, CFA12 Map Book).

6.3.11 The embankments will be a minimum of 3.6m above existing ground level through the area of risk. There will therefore be a freeboard of at least 3.3m for the minimum top of rail level at the valley crossing over the 1 in 200 years return period (0.5% annual probability) surface water flood water level (no risk).

Tetchwick Brook

6.3.12 The Proposed Scheme will cross the Tetchwick Brook just downstream of the Buckinghamshire Railway Centre near Crossroads Farm. Immediately downstream of the intersection with the Proposed Scheme the Tetchwick Brook is currently culverted beneath Quainton Road. The culvert will be realigned under the Proposed Scheme. The combined Station Road and Quainton Road overbridge embankment will lie along the base of the natural valley. Where the Proposed Scheme intersects with the Tetchwick Brook the FMfSW shows an approximately 175m wide band along the base of the valley to be at risk of shallow flooding from surface water runoff during both the 1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall event. The Station Road or Quainton Road southern embankment will lie within an area shown to be at risk of deep (greater than 300mm in depth) flooding during the 1 in 200 years return period (0.5% annual probability) rainfall event and shallow flooding during the 1 in 30 years return period rainfall event. Design elements that fall within the areas at risk of flooding are Quainton south embankment and Station Road overbridge as shown on Map CT-06-050 (Volume 2, CFA12 Map Book).

6.3.13 The embankment will be a minimum of 1.8m above existing ground level through the area of risk. There will therefore be a freeboard of at least 1.5m for the minimum top of rail level at the valley crossing over the 1 in 200 years return period (0.5% annual probability) surface water flood water level (no risk).

6.3.14 Although built on to a low embankment the southern approach embankment for the realigned Station Road overbridge will lie within the area shown on the FMfSW to be at risk of deep flooding during the extreme rainfall event. Further, the embankment lies along the base of the valley parallel to the direction of flow. Surface water, however, will be intercepted by the Proposed Scheme land drainage before being conveyed beneath the road embankment.

Doddershall Brook and tributary

6.3.15 The Proposed Scheme will cross two valleys near to Doddershall House associated with the Doddershall Brook and a tributary. At both valley crossings the FMfSW shows areas of deep ponding upstream of the existing railway with floodwaters conveyed beneath the existing embankment in culverts. The Proposed Scheme will be on the downstream side of the existing embankment and consequently will cross narrow areas of only shallow flooding for both the 1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall event along both valleys. Design elements that lie within the area shown to be at risk of flooding are Doddershall embankment and the Footpath QUA/26 accommodation underbridge, as shown on Map CT-06-051 (Volume 2, CFA12 Map Book).

6.3.16 The embankment will be a minimum of 3.4m above existing ground level at the southern valley crossing and 2.2m above existing ground level at the northern valley crossing. There will therefore be a freeboard of at least 3.1m and 1.9m respectively between the 1 in 200 years return period (0.5% annual probability) surface water runoff flood water level and the minimum top of rail level at the valley crossing (no risk).

6.3.17 The Footpath QUA/26 accommodation underbridge would be at existing ground levels beneath the Proposed Scheme. The proposed underbridge structure is located at the edge of the area shown to be at risk and will therefore potentially be at risk of flooding. Surface water, however, will be intercepted by the Proposed Scheme land drainage and discharged beneath the route via a culvert.

River Ray

6.3.18 The FMfSW indicates areas of deep flooding along the valley of the River Ray in the 1 in 200 years return period (0.5% annual probability) rainfall event prior to surface water runoff reaching the channel. The extents of flooding shown are within the flood zone extents for the watercourse and since flooding from surface water runoff occurs early in any given rainfall event, is likely to have receded prior to the onset of any significant flooding from the watercourse. On this basis there is unlikely to be any significant cumulative effect due to combined flooding from surface water and from the watercourse that would not already be accounted for in the analysis of the River Ray used to assess the risk of flooding from rivers. As a result, the flood risk considered in the section on 'risk of flooding from rivers' will be the dominant source of risk to the Proposed Scheme.

Lee Wood Farm Ditch

6.3.19 The Proposed Scheme will cross the Lee Wood Farm Ditch near Woodlands Farm where it is culverted beneath the existing railway embankment west of the Proposed Scheme. There are a number of areas shown along the existing railway and the valley of the Lee Wood Farm Ditch to be at risk of surface water flooding although the Proposed Scheme will not lie directly within any of these areas. The Grendon Underwood embankment will be raised above ground level in the vicinity of all of these scattered areas of ponding. In addition, land drainage will be constructed along either side of the Proposed Scheme, designed with sufficient capacity to contain the 1

in 100 years return period (1% annual probability) flood event including an allowance for climate change, discharging to the Lee Wood Farm Ditch via a balancing pond some 450m downstream of the Proposed Scheme. The land drains will intercept overland surface water flow and it is unlikely that the Proposed Scheme will be at risk of flooding from this source.

Muxwell Brook and Mega Ditch

6.3.20 The FMfSW indicates areas of deep flooding along the valley of the Muxwell Brook in the 1 in 200 years return period (0.5% annual probability) rainfall event prior to surface water runoff reaching the channel. Additional areas of flooding are shown along the Mega Ditch. The extent of flooding along the natural valley are within the flood zone extents for the watercourse and since flooding from direct surface water runoff occurs early in any given rainfall event is likely to have receded prior to the onset of any significant flooding from the watercourse. The Mega Ditch is significantly greater than 300mm in depth whilst the Proposed Scheme will be above existing ground levels through the area. On this basis there is unlikely to be any significant cumulative effect due to combined flooding from surface water runoff and from the watercourse that is not accounted for in the analysis of the Muxwell Brook. As a result the flood risk considered in paragraphs 6.2.11 to above will be the dominant source of risk to the Proposed Scheme.

6.4 Risk of flooding from groundwater

6.4.1 The bedrock within the study area is formed entirely of unproductive clays or mudstones, and there is therefore no identifiable risk of groundwater flooding arising from bedrock aquifers. The BGS dataset, however, indicates that the Proposed Scheme will intersect areas of very high susceptibility to flooding from groundwater within the local alluvium and head deposits (superficial deposits) along a number of the river valleys, specifically the Fleet Marston Brook, Doddershall Brook, River Ray and Muxwell Brook. These areas are confined to the valleys of these watercourses and are not extensive within the study area. This is confirmed in the BuCC PFRA where it is reported that less than 25% of the study area is at risk of groundwater flooding.

6.4.2 All valleys with a susceptibility to groundwater flooding will be crossed on embankment, and therefore the risk of flooding to the Proposed Scheme is negligible (no risk).

6.5 Risk of flooding from drainage systems

6.5.1 The Proposed Scheme will not pass through any urban areas for the full extent within the study area. There will consequently be no significant risk to the Proposed Scheme of flooding from drainage systems within the study area.

6.6 Risk of flooding from artificial sources

6.6.1 The Proposed Scheme will not intersect any areas shown on the Environment Agency RIM to be at risk of flooding in the event of impounded reservoir failure. No further artificial water bodies have been identified within the study area that will constitute a significant risk of flooding to the Proposed Scheme.

6.7 Summary of baseline flood risk

Table 4: Summary of baseline flood risk for all sources of flooding in CFA12

Source of flooding	Location of flooding source	Flood risk category	Elements at risk	Assessment of risk
River	River Ray	Very High Flood Zone 3b	Adam's embankment	Top of rail level will be >1m above 1,000 years return period water level
River	Muxwell Brook	Very High Flood Zone 3b	Grendon Underwood embankment No.1	Top of rail level will be >1m above 1,000 years return period water level
			Grendon Underwood embankment No.2	
			Footpath CAG/2 underbridge	Underbridge will be at least 800mm below flood water levels and up to 2m below flood water levels
Surface water	Cranwell Farm	Medium 200 years FMfSW <0.3m 30 years FMfSW <0.3m	Bicester Road embankment	Top of rail level will be >1m above estimated flood water level
Surface water	Wayside Farm dry valley	Low 200 years FMfSW <0.3m	Realigned A41 Bicester Road and Blackgrove Road	Blackgrove Road will be on embankment.
Surface water	Briar Hill Farm dry valley	Low 200 years FMfSW <0.3m	Waddesdon south cutting	Top of rail level will be in cutting below adjacent ground level Land drainage will collect surface water runoff and provide attenuation.
Surface water	Glebe Farm dry valley	Medium 200 years FMfSW <0.3m 30 years FMfSW <0.3m	Waddesdon embankment	Top of rail level will be >1m above estimated flood water level
			Glebe Farm PRoW underbridge	Underbridge will be below ground levels within area at risk Land drainage will collect surface water runoff and provide attenuation.
Surface water	Fleet Marston Brook	Low 200 years FMfSW <0.3m	Waddesdon north cutting	Top of rail level will be >1m above estimated flood water level
			Quainton south embankment	

Source of flooding	Location of flooding source	Flood risk category	Elements at risk	Assessment of risk
Surface water	Tetchwick Brook	Medium 200 years FMfSW <0.3m 30 years FMfSW <0.3m	Quainton south embankment	Top of rail level will be >1m above estimated flood water level
		Medium 200 years FMfSW >0.3m 30 years FMfSW <0.3m	Station Road overbridge	Station Road is raised on embankment. Land drainage will be provided in the form of culverts and replacement floodplain storage.
Surface water	Doddershall Brook and tributary	Medium 200 years FMfSW <0.3m 30 years FMfSW <0.3m	Doddershall embankment	Top of rail level will be >1m above estimated flood water level
			Woods Accommodation underbridge	Underbridge will be at existing ground level Land drainage will be provided in the form of a drop-inlet culvert
Surface water	Lee Wood Farm Ditch	Low 200 years FMfSW <0.3m	Grendon Underwood embankment	Top of rail level will be >1m above estimated flood water level

7 Flood risk management measures

7.1 Risk of flooding from rivers

7.1.1 The Proposed Scheme will be raised above crossings of floodplains (river flooding) such that the risk of flooding from this source is less than 0.1%. Therefore there are no instances where the Proposed Scheme will be at significant risk of river flooding and consequently no specific management measures are required.

7.1.2 The Footpath CAG/2 underbridge, which will serve to accommodate a diverted PRoW, will be at significant risk of flooding. The PRoW is not, however, a promoted route and so no further specific mitigation is proposed for this PRoW.

7.1.3 At all flood zone crossings replacement floodplain storage will be provided upstream of the Proposed Scheme, or adjacent to the area removed, for all losses in floodplain storage. This applies to the River Ray and Muxwell Brook crossings.

7.2 Risk of flooding from surface water

7.2.1 The FMfSW shows the extent of flooding due to rainfall that would occur prior to collection of water into streams or designated drainage infrastructure. By collecting the flows from the dry valley into an adequately designed land drainage system, the Proposed Scheme will effectively remove the risk of surface water flooding from the point at which the flow is intercepted.

7.2.2 Measures to manage the risk of flooding from surface water runoff includes:

- provision of replacement storage and surface water attenuation facilities to restrict peak surface water runoff rates to existing greenfield rates;
- culverts have been designed with adequate capacity to convey the 1 in 100 years (1% annual probability) flow including an allowance for climate change; and
- design of culverts with internal 600mm freeboard and 300mm allowance for siltation to minimise the chances of blockage or future capacity restrictions

7.2.3 There will not be any anticipated changes to the risk of flooding from surface water sources as a result of the Proposed Scheme within the study area; therefore no specific management measures will be required.

7.3 Risk of flooding from groundwater

7.3.1 There are no locations where the Proposed Scheme will be below ground level within an area with a susceptibility to groundwater flooding. Therefore no risk of flooding to the Proposed Scheme is expected and no specific management measures will be required. Similarly, there will not be any significant impact on the risk of flooding from groundwater arising from the Proposed Scheme and therefore no specific management measures will be required.

7.4 Risk of flooding from drainage systems

7.4.1 There will be no risk of flooding from drainage systems to the Proposed Scheme, nor will there be any anticipated effects on the risks of flooding from drainage systems within the study area arising from the Proposed Scheme. Therefore no specific mitigation will be required.

7.5 Risk of flooding from artificial sources

7.5.1 There are no instances where the Proposed Scheme will be at significant risk of flooding from artificial sources, nor will there be any anticipated effects on the risks of flooding from artificial sources within the study area arising from the Proposed Scheme. Therefore no specific mitigation will be required.

8 Post-development flood risk assessment

8.1 Local receptors

8.1.1 In addition to the risk of flooding that exists to the Proposed Scheme there is potential for the Proposed Scheme to affect the risk of flooding to third party receptors by altering flow mechanisms across the range of flood sources. All local receptors with a potential flood risk are identified in Section 5.2 of this report. For the Proposed Scheme to have an impact on a given receptor the identified pathway for that receptor must be shared by both the subject receptor and the Proposed Scheme with the result that a number of cases can be excluded immediately. Table 5 summarises the shared pathways between the Proposed Scheme and each receptor, and identifies cases where no shared pathway exists.

Table 5: Shared flood risk pathways in CFA12

Local receptor	Vulnerability classification as per the NPPF	Pathway	Shared pathway between Proposed Scheme and receptor
Lower Blackgrove Farm	More vulnerable	Groundwater - very high	Alluvial deposits, not shared with Proposed Scheme (no shared pathway).
Waddesdon village	More vulnerable	Surface water 30 years - deep Overloaded sewers	No shared pathway.
Waddesdon sewage treatment works	Less vulnerable	Surface water 30 years - shallow	Waddesdon embankment and Glebe Farm PRoW will be immediately upstream.
Little Manor Holding	Less vulnerable	Surface water 30 years - shallow	No shared pathway.
Buckinghamshire Railway Centre	Less vulnerable	Surface water 200 years - shallow	Quainton south embankment will be approximately 250m downstream.
Doddershall House access	More vulnerable	Surface water 30 years - deep	Doddershall embankment will be approximately 450m upstream.
Woodlands Farm access	More vulnerable	River flooding Flood Zone 3 Surface water 30 years - shallow	Adam's embankment, underbridge and culvert will be approximately 50m upstream of the River Ray.
Access road to Upper Greatmoor Farm and Lower Greatmoor Farm	More vulnerable	River flooding Flood Zone 3 Surface water 30 years - shallow	Grendon Underwood embankment will be approximately 1.2km upstream on Muxwell Brook.

8.1.2 There is also the potential for the Proposed Scheme to change the baseline risk of flooding described in Section 6 of this report. Though designed such that the probability of the Proposed Scheme flooding in any given year is less than 1 in 1,000,

any change to the baseline risk of flooding could impact on the assessment of flood risk to the Proposed Scheme. All cases of flood risk discussed in Section 6 of this report are therefore reconsidered regardless of the presence or otherwise of third party local receptors.

8.2 Impact on risk of flooding from rivers

River Ray

Description

8.2.1 The River Ray is a tributary of the River Cherwell and flows perpendicular to the Proposed Scheme. The Proposed Scheme will cross the watercourse close to Woodlands Farm. The land use in the floodplain is agricultural.

8.2.2 The Proposed Scheme will be built alongside the existing single-track railway embankment at the crossing of the River Ray. The existing railway crosses the watercourse and a private access track on a single span viaduct. The River Ray is culverted beneath the access track at the same location. In order to maintain the existing private access the Proposed Scheme will include a new underbridge designed to match the existing provision with the culvert to be similarly extended.

Local receptors and land use

8.2.3 The only formal receptor to lie within or close to the extent of the area at risk of flooding from the River Ray within the study area is Woodlands Farm. Although the house and farm buildings themselves do not lie within the floodplain of the River Ray the access road to the farm is crossed by the flood zones and consequently access to the property will be flooded in the existing circumstances.

8.2.4 The land use in the floodplain around the Proposed Scheme location is largely made up of arable farm land and pasture. There is a private access track that currently passes beneath the existing railway line at the same location as the culvert. This access track, however, does not lead to any formally identified receptors.

Assessment of effects

8.2.5 The key design elements that have the potential to affect flood flows in the River Ray are the Adam's embankment and Adam's underbridge and River Ray culvert. The Proposed Scheme will extend both existing structures with the main underbridge designed to match the width and height of the existing structure. The culvert will be extended to maintain access through the underbridge.

8.2.6 No hydraulic model is available for the River Ray and the effect of the existing culvert on flood flows has therefore not been quantified. The existing culvert is formed of a brick archway approximately 35m in length. The Proposed Scheme will require the culvert to be extended by 5m to the edge of the new underbridge plus an estimated 10m to enable the access track to approach the underbridge (based on the current additional length). The culvert will therefore be extended by approximately 50%.

8.2.7 The culvert extension will be designed to convey the predicted 1 in 100 years return period (1% annual probability) flood flow in the River Ray of 5.9m^3/s including an

allowance for climate change, siltation and blockage. A 2.1m square box culvert will be constructed which will have greater capacity than the existing brick arch culvert.

8.2.8 Extending an existing culvert would increase friction losses potentially causing a reduction in the conveyance capacity of the watercourse at the Proposed Scheme crossing. Such an effect could potentially lead to an increased risk of flooding upstream with the severity of the effect dependent on the existing culvert gradient and capacity. The proposed extension however, will have a significantly greater capacity than the current culvert due to its increased size, so it is likely that any such effect will be adequately mitigated.

8.2.9 The approach embankments to the Adam's underbridge will occupy approximately 2,600m^2 of floodplain and therefore potentially displace floodwaters. Since the embankments will be downstream of an existing floodplain flow obstruction there will be no significant additional obstruction to floodplain flow. The loss in floodplain storage will be mitigated through the provision of replacement floodplain storage as shown on Map CT-06-052 (Volume 2, CFA12 Map Book).

8.2.10 The main access driveway to Woodlands Farm is located approximately 50m downstream of the Proposed Scheme. Although an extension of a culvert would generally be expected to result in increased risks of flooding upstream and reduced risks downstream the effects of the embankment could be more significant at this location due to the proximity of the loss in storage and the obstruction caused by the driveway crossing of the watercourse. Since the access road forms the only vehicular access route to Woodlands Farm and the residential properties located around the complex (Woodlands Lodge, Woodlands Barn and Woodlands Farm House) there are potential consequences to increasing the severity of flooding on the road. Due to the close proximity of the road to the Proposed Scheme the displacement of flood storage volume resulting from the construction of embankments within the floodplain could affect flood depths on the road. Replacement floodplain storage is, however, proposed between the road and the Proposed Scheme and will offset any potential effects.

8.2.11 The Proposed Scheme is not expected to have any significant impact on the risk of flooding from the River Ray.

Muxwell Brook

Description

8.2.12 The Muxwell Brook is a tributary of the River Ray, and is conveyed beneath the existing railway embankment via a combination of a culvert at the formalised channel of the watercourse and additional flood relief culverts including the Footpath CAG/2 underbridge. The Proposed Scheme will cross the watercourse and floodplain on embankment alongside and downstream of the existing railway embankment with culvert extensions provided to convey the watercourse beneath the new structure. The land use within and adjacent to the floodplain upstream of the crossing is pasture on the left (southern) bank and woodland on the right bank.

8.2.13 Downstream of the crossing are the Calvert landfill and site of the proposed Greatmoor EfW facility. Significant works to the Muxwell Brook are proposed in

connection with this proposed facility. The design of the restoration works were undertaken in consultation with the Environment Agency and this assessment assumes that the extant planning permission for these works will be adhered to.

Local receptors and land use

8.2.14 Upper Greatmoor Farm (allocated for demolition as part of the Greatmoor EfW facility) and Lower Greatmoor Farm are the only formal receptors that lie within or close to the extent of the area at risk of flooding from the Muxwell Brook within the study area and could therefore be affected by the Proposed Scheme near the Muxwell Brook. Although the house and farm buildings themselves do not lie within the floodplain the access road is crossed by the flood zones and consequently access from the properties may be impeded during flood events. The access road crosses the floodplain approximately 1.2km downstream of the Proposed Scheme.

8.2.15 The agricultural land within the floodplain in the vicinity of the Proposed Scheme is owned by Portway Farm and rented to Upper and Lower Greatmoor Farms.

Assessment of effects

8.2.16 The key design elements that have the potential to affect flood flows in the Muxwell Brook are the Grendon Underwood embankments and Footpath CAG/2 underbridge together with the Grendon Underwood embankment culvert extensions. The Proposed Scheme will extend the existing structures with the Footpath CAG/2 underbridge designed to match the width and soffit level of the existing structure.

8.2.17 No hydraulic model is available for the Muxwell Brook and the effect of the existing culverts on flood flows has therefore not been quantified. The mechanism of flooding at the Muxwell Brook is described in Section 6. There are three existing pathways for floodwater across the existing railway embankment: the channel culvert, Footpath CAG/2 underbridge and between them, a second culvert at the base of the natural valley.

8.2.18 The Muxwell Brook culvert extension will be designed to convey the predicted 1 in 100 years return period (1% annual probability) flood flow including an allowance for climate change in the Muxwell Brook of 6.6m^3/s, as well as allowances for siltation and blockage. A 2.4m square box culvert, approximately 25m long, is proposed which will have significantly greater capacity than the existing brick arch culvert. The existing structure is described as a circular brick arch culvert of 0.46m diameter and is approximately 20m long. During the site familiarisation visit the existing culvert was completely submerged both upstream and downstream although the stream was not in a flooded state.

8.2.19 The culvert at the base of the valley is approximately 6m to the north of the Footpath CAG/2 underbridge and is a 0.91m semi-circular brick arch structure. The existing culvert will be extended with a 1,350mm section which will have greater capacity than the existing. On the basis that the existing Muxwell Brook culvert appears to be submerged under normal flow conditions all additional floodwaters arising during flood events are likely to pass along the natural valley and through this culvert and the nearby Footpath CAG/2 underbridge.

8.2.20 The Footpath CAG/2 underbridge extension will be constructed below existing ground levels. The approach to the underpass falls within Flood Zones 3 and 2. Although the proposed underpass will not in itself cause any adverse effects on the risk of flooding from the Muxwell Brook, the frequency and severity of flooding within the underpass itself will increase relative to the existing scenario with consequent impacts to the public footpath (Footpath CAG/2/1) that will be diverted through this underbridge.

8.2.21 Extending existing culverts will increase friction losses potentially causing a reduction in the conveyance capacity of the watercourse at the Proposed Scheme crossing. Such an effect could potentially lead to an increased risk of flooding upstream with the severity of the effect dependent on the existing culvert gradient and capacity. The proposed extensions will however have greater capacity than the existing culverts due to their increased size, so it is likely that any such effect will be adequately mitigated.

8.2.22 The Proposed Scheme embankments will occupy 830m^2 of floodplain and therefore displace floodwaters which will result in an increase in the risk of flooding from the Muxwell Brook on the downstream side of the Proposed Scheme close to the embankments. Since the embankments will be downstream of an existing floodplain flow restriction there will be no significant additional obstruction to floodplain flow. The loss in floodplain storage will be mitigated through the provision of replacement floodplain storage as shown on Map CT-06-053 (Volume 2, CFA12 Map Book).

8.2.23 The access driveway to Upper and Lower Greatmoor Farms is located over 1km downstream of the Proposed Scheme. The effects of displacement are expected to be localised, and the effect on the risk of flooding along the access road to Lower and Upper Greatmoor Farms will be negligible.

8.3 Impact on risk of flooding from surface water

8.3.1 The potential impact on the risk of flooding from surface water runoff within the River Ray and Muxwell Brook valleys are closely related to the impacts on the risk of flooding from watercourses and are therefore considered alongside river flooding in Section 8.2.

Cranwell Farm

8.3.2 As the Proposed Scheme enters the study area it will cross an area shown on the FMfSW to be at risk of shallow flooding from direct surface water runoff during both the 1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall events. The area is associated with a well-defined dry valley that runs parallel to the A41 Bicester Road from west to east towards the Fleet Marston Brook. Design elements that lie within the area at risk of flooding are the Bicester Road embankment and the Bicester Road overbridge.

8.3.3 At this location the Proposed Scheme will be on low embankment and therefore surface water flood flows in the valley will be disrupted. Balancing ponds are proposed in this location to manage surface water runoff from the Proposed Scheme, with the outfall of the pond discharging into a culvert beneath the embankment to the north. All culverts will be sized to convey the 1 in 100 years return period (1% annual

probability) event including an allowance for future climate change, siltation and blockage. Separate balancing ponds are provided for the realigned A41 Bicester Road.

8.3.4 As a result of the design of the land drainage system including balancing ponds, the Proposed Scheme will have no significant effect on the risk of flooding from surface water at the Cranwell Farm valley crossing.

Wayside Farm dry valley

8.3.5 To the east of Wayside Farm the Proposed Scheme will cross an area shown on the FMfSW to be at risk of shallow flooding from direct surface water runoff during the 1 in 200 years return period (0.5% annual probability) rainfall event. The area of risk runs along a field boundary and, although disconnected from downstream areas at risk of flooding, is associated with a dry valley that flows in a north-easterly direction towards the Fleet Marston Brook. The design elements that lie within the area at risk of flooding are the Waddesdon South cutting and realigned A41 Bicester Road as shown on Map CT-06-048 (Volume 2, CFA12 Map Book).

8.3.6 The Proposed Scheme will be in cutting at the valley crossing. Surface water flood flows are expected to be low and will be collected in the drainage system for the Proposed Scheme.

8.3.7 There are no formal receptors within the area at risk from this source within the study area. As a result of the design of the land drainage system and balancing ponds the Proposed Scheme will have no significant effect on the risk of flooding from surface water at the Wayside Farm dry valley crossing.

Briar Hill Farm dry valley

8.3.8 To the east of Briar Hill Farm the Proposed Scheme will cross an area shown on the FMfSW to be at risk of shallow flooding from direct surface water runoff during the 1 in 200 years return period (0.5% annual probability) rainfall event. The area at risk of flooding runs along a field boundary and is associated with a narrow dry valley that flows in a north-easterly direction towards the Fleet Marston Brook. The design elements that lie within the area at risk of flooding are the Waddesdon south cutting and the realigned Blackgrove Road.

8.3.9 The Proposed Scheme will be in cutting at the valley crossing. Ground level information suggests that Briar Hill Farm is situated on the watershed between two catchments and the contributing catchment area for the dry valley measured using LiDAR information is approximately 0.1km^2. Surface water flood flows will therefore be low and will be collected in the drainage system for the Proposed Scheme.

8.3.10 There are no formal receptors within the area at risk from this source within the study area. As a result of the design of the land drainage system and balancing ponds the Proposed Scheme will have no significant effect on the risk of flooding from surface water at the Briar Hill Farm valley crossing.

Glebe Farm dry valley

8.3.11 Where the Proposed Scheme crosses a valley near to Glebe Farm the FMfSW shows a 200m wide area at risk of shallow flooding from direct surface water runoff during the

1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall events. Design elements that fall within the area at risk of flooding are Waddesdon embankment and Glebe Farm PRoW underbridge.

8.3.12 The Waddesdon embankment and Glebe Farm PRoW underbridge will completely obstruct flood flows within the dry valley. The proposed underbridge will be located directly at the base of the dry valley with surface water intercepted by the Proposed Scheme drainage system and discharged to a balancing pond before being conveyed beneath the Proposed Scheme to a drainage ditch downstream. In addition, pumps will be provided to remove ponded surface water in the subway to a balancing pond. All land drainage elements will be designed with sufficient capacity to convey the 1 in 100 years return period (1% annual probability) surface water flood event including an allowance for climate change, siltation and blockage.

8.3.13 The Waddesdon sewage treatment works is located immediately downstream of the proposed embankment. The area of rainfall catchment upstream of the sewage treatment works will be collected and discharged downstream of the sewage treatment works. Therefore, the existing risk of flooding to this receptor will potentially be reduced with the Proposed Scheme producing a commensurate small beneficial effect.

Fleet Marston Brook

8.3.14 Where the Proposed Scheme crosses the Fleet Marston Brook the FMfSW shows a narrow band along the valley bottom to be at risk of shallow flooding from surface water runoff during the 1 in 200 years return period (0.5% annual probability) rainfall event. There are significant areas of ponding shown upstream of Quainton Road just south of the Proposed Scheme. These, however, appear to be associated with the raised road embankment and floodwaters are shown to collect within the watercourse on the downstream side of the road. Design elements that fall within the area at risk of flooding are Waddesdon north cutting (above ground through the area of risk) and Quainton south embankment.

8.3.15 The Proposed Scheme will cross a very small area of risk and it is therefore unlikely that displacement of flood waters will cause any significant effects to the risk of flooding from this source. The Fleet Marston Brook will be conveyed beneath the embankment in a 1,350mm diameter culvert designed to convey the estimated 1 in 100 years return period (1% annual probability) flood flow including an allowance for climate change of 1.7m^3/s as well as allowances for siltation and blockage. No adverse impacts on the risks of flooding from the Fleet Marston Brook are expected either upstream or downstream of the Proposed Scheme.

Tetchwick Brook

8.3.16 The Proposed Scheme will cross the Tetchwick Brook downstream of the Buckinghamshire Railway Centre near Crossroads Farm. Immediately downstream of the intersection with the Proposed Scheme the Tetchwick Brook is currently culverted beneath Quainton Road which will be realigned under the Proposed Scheme. The combined Station Road and Quainton Road overbridge embankment will lie along the base of the valley. Where the Proposed Scheme intersects with the Tetchwick Brook

the FMfSW shows an approximately 175m wide band along the base of the valley to be at risk of shallow flooding from direct surface water runoff during both the 1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall events. The Station Road overbridge southern approach embankment will lie within an area shown to be at risk of deep flooding during the 1 in 200 years return period (0.5% annual probability) rainfall event and shallow flooding during the 1 in 30 years return period rainfall event. Design elements that fall within the area at risk of flooding are Quainton south embankment and the Station Road overbridge.

8.3.17 The Quainton south embankment will cross the double valley of the Tetchwick Brook and tributary, obstructing surface water flood flows. Surface water will be intercepted by the Proposed Scheme land drainage, and discharged beneath the Proposed Scheme in a single 1.35m square box culvert to a balancing pond. The culvert will be designed to convey the estimated 1 in 100 years return period (1% annual probability) flood flow including an allowance for climate change of 0.85m^3/s, as well as allowances for siltation and blockage.

8.3.18 The southern approach embankment for the realigned Station Road overbridge will lie along the base of the valley parallel to the direction of flow. One highway crossing of the Tetchwick Brook is required. The incoming land drain from the north requires a short diversion and a crossing of a land drain alongside the existing Station Road at the southern extent. All land drainage elements will be designed to convey the estimated 1 in 100 years return period (1% annual probability) flood flow including an allowance for climate change (1.2m^3/s for the Tetchwick Brook) as well as allowances for siltation and blockage.

8.3.19 There will be no adverse effect on the risk of flooding from this source at the Buckinghamshire Railway Centre arising from the Proposed Scheme.

Doddershall Brook and Tributary

8.3.20 The Proposed Scheme will cross two valleys near to Doddershall House associated with the Doddershall Brook and a tributary. At both valley crossings the FMfSW shows areas of deep ponding upstream of the existing railway embankment with floodwaters conveyed beneath the existing embankment in culverts. The Proposed Scheme will be on the downstream side of the existing embankment and consequently will only cross narrow areas of shallow flooding for both the 1 in 30 years and 1 in 200 years return period (3.3% and 0.5% annual probability) rainfall events along both valleys.

8.3.21 The Doddershall embankment will cross a small area of risk and it is therefore unlikely that displacement of flood waters will cause any significant effects on the risk of flooding from this source. There will be no adverse effect on the risk of flooding from this source to the access road to Doddershall House as a result of the Proposed Scheme.

8.3.22 The FMfSW shows extensive ponding on the upstream side of the existing embankment suggesting that the current culverts have insufficient capacity to convey flood flows.

8.3.23 There are five culverts beneath the existing embankment within the area of risk, all of which will be extended under the Proposed Scheme. Doddershall embankment culverts No.1 and No.2 lie within the area at risk from the tributary. Doddershall embankment culvert No.3 lies within the area at risk from the Doddershall Brook. Quainton culvert extensions 1 and 2 lie within the area at risk of flooding along the Doddershall Brook valley. The Doddershall Brook tributary main channel will pass through Doddershall embankment culvert No.1 whilst the Doddershall Brook will pass through Quainton culvert extension No.2.

8.3.24 With the exception of the Doddershall Brook culvert all existing culverts are 900mm semi-circular brick arch structures. These will all be extended using 1,350mm culvert. The Doddershall Brook culvert, which is currently a 1.22m brick arch culvert, will be extended using a 1.8m square box culvert designed to convey the 1 in 100 years return period (1% annual probability) flood flow including an allowance for climate change of 3.2m^3/s. Since the proposed extensions will be larger than the current provision it is likely that any upstream effects arising from these culvert extensions will be negligible.

Lee Wood Farm Ditch and Greatmoor Watercourses

8.3.25 The Proposed Scheme will cross the Lee Wood Farm Ditch near Woodlands Farm where it is culverted beneath the existing railway embankment. There are a number of areas shown along the existing railway and the valley of the Lee Wood Farm Ditch to be at risk of surface water flooding although the Proposed Scheme will not lie directly within any of these areas. The Grendon Underwood embankment will be raised above ground level in the vicinity of all of these scattered areas of ponding with land drainage constructed along either side of the Proposed Scheme at this location designed with sufficient capacity to contain the 1 in 100 years return period (1% annual probability) flood event including an allowance for climate change. Collected flood flows will discharge to the Lee Wood Farm Ditch via a balancing pond some 450m downstream of the Proposed Scheme. The land drains will intercept overland surface water flood flows and will potentially remove surface ponding in the area.

8.3.26 There are two locations along the Grendon Underwood embankment where ponding is shown on the FMfSW on the upstream side of the existing rail embankment. At both of these locations extensions to the existing culverts are proposed to maintain runoff conveyance across the Proposed Scheme. These are the Greatmoor culvert extension and Grendon Underwood embankment culvert No.1 and culvert No.2. Both existing culverts are 900mm semi-circular brick arch structures. These will both be extended using 1.35m square box culverts and since the proposed extensions will be significantly larger than the current provision it is likely that any upstream effects arising from these culvert extensions will be negligible. Consequently, there will be no significant effects on the risk of flooding from the Lee Wood Farm Ditch and nearby watercourses and dry valleys arising from the Proposed Scheme.

8.4 Impact on risk of flooding from groundwater

8.4.1 The bedrock geology within the study area consists entirely of unproductive clay and mudstones, with no associated risk of groundwater flooding. Superficial aquifers are

present within the alluvial and head deposits along the river valleys, which are likely to be in hydraulic continuity with the watercourses. More detail on the hydrogeology within the study area is provided in Volume 5: Appendix WR-002-012.

8.4.2 All secondary superficial aquifers within the study area will be crossed by embankments and culverts and no obstruction to groundwater flows is therefore expected. There will therefore be no impact on the risk of flooding from groundwater arising from the Proposed Scheme.

8.5 Impact on risk of flooding from drainage systems

8.5.1 The Proposed Scheme will not pass through any urban areas for the full extent within the study area. All highway crossings required will be diverted or re-designed as bridges or underpasses with the exception of those that will be crossed on viaduct which will remain unchanged. Highway drainage for all new or realigned roads will be designed in accordance with the relevant design guides and regulations and consequently no increase in the risk of flooding arising from overloaded highway drains is anticipated.

8.6 Impact on risk of flooding from artificial sources

8.6.1 The Proposed Scheme will not cross any areas shown on the Environment Agency RIM to be at risk of flooding in the event of impounded reservoir failure. Consequently, the Proposed Scheme will not affect the risk of flooding from this source within the study area.

8.7 Summary of potential impacts and effects on flood risk

Table 6: Summary of potential flood risk impacts and effects in CFA12

Receptor	Vulnerability classification	Pathway	Impacts and effects
General Proposed Scheme	N/A	River flooding	Minor afflux and loss of floodplain at River Ray and Muxwell Brook crossings offset by replacement floodplain storage.
		Surface water flooding	Potential minor localised changes in flow and flood mechanism due to collection of surface water flows into formal drainage systems. No significant effects.
		Groundwater	No significant effects expected.
		Drainage systems	No significant effects expected.
		Artificial sources	No significant effects expected.
Waddesdon sewage treatment works	Less vulnerable	Surface water 30 years - shallow	Slight beneficial effect through the collection of flood flows into a formalised land drainage network reducing the risk at the Waddesdon sewage treatment works.
Buckinghamshire Railway Centre	Less vulnerable	Surface water 200 years - shallow	No significant effects expected.
Doddershall House access	More vulnerable	Surface water 30 years - deep	No significant effects expected.
Woodlands Farm access	More vulnerable	River flooding Flood Zone 3 Surface water 30 years - shallow	No significant effects expected.
Access road to Upper Greatmoor Farm and Lower Greatmoor Farm	More vulnerable	River flooding Flood Zone 3 Surface water 30 years - shallow	No significant effects expected.

9 Conclusions

9.1 Summary

9.1.1 The Proposed Scheme within CFA12 extends from just south of the A41 Bicester Road, near Fleet Marston to the north-west corner of Sheephouse Wood, south-west of Calvert. The study area includes all areas within 1km of the Proposed Scheme which includes areas at risk of flooding from various sources as follows:

- areas at risk of river flooding from the River Ray and Muxwell Brook, as well as the Doddershall Brook and Fleet Marston Brook;
- areas at risk of flooding arising from surface water runoff together with four minor watercourse crossings; and
- areas susceptible to groundwater emergence within superficial deposits and thus at risk of groundwater flooding.

9.1.2 The Proposed Scheme will be at least 1m above design flood water levels within all areas at risk of flooding from rivers, groundwater, drainage and artificial water body sources. Risks from these sources will be negligible. There are some areas at risk of flooding from surface water runoff where the Proposed Scheme will be less than 1m above ground levels. This risk will be managed by the providing sufficient capacity in the drainage system of the Proposed Scheme to collect, attenuate and discharge surface water to a suitable outfall. Design standards are such that no flooding of the Proposed Scheme is expected under normal operating conditions.

9.1.3 The dominant land use within the study area is rural agriculture.

9.1.4 There are no areas where specific mitigation for risks of flooding to the Proposed Scheme or for impacts arising would be required.

9.2 Residual flood risks to Proposed Scheme

9.2.1 Residual flood risks arise in situations that are not included in standard design scenarios or infrastructure fails for example when a culvert becomes blocked causing flooding upstream. Consequently, there may be areas where the potential severity of flooding may exceed the design standard under certain circumstances.

Residual flood risks from rivers

River Ray

9.2.2 The extension to the River Ray culvert will be designed including allowances for siltation and blockage, and consequently the risk of culvert failure causing an increase in existing flood risk as a result of the Proposed Scheme will be minimised. There remains, however, a residual risk arising from potential blockage of the existing culvert. In such an event, rising flood waters would bypass the culvert by flowing through the existing underbridge and would therefore not cause a significant additional flood risk to the Proposed Scheme.

9.2.3 The Woodlands Farm access track crosses the River Ray 50m downstream of the Proposed Scheme. The track is not significantly raised above surrounding ground and floodwaters will be expected to bypass the culvert in the event of a blockage without any significant increase in the risk of flooding upstream.

Muxwell Brook

9.2.4 The extension to the Muxwell Brook culvert will be designed including allowances for siltation and blockage. There remains, however, a residual risk arising from potential blockage of the existing culvert. In the event of blockage of the existing culverts within the Muxwell Brook floodplain floodwaters will be redirected via the Sheephouse Wood underbridge. As a result, there will be no additional risk of flooding to the Proposed Scheme although the potential severity of flooding within the Footpath CAG/2 underbridge would be increased relative to the normal case.

9.2.5 There are a number of small access bridges spanning the Muxwell Brook and Mega Ditch downstream of the Proposed Scheme. Examination of the ground levels, however, indicates that there are no significant raised obstructions to flood flows. Any blocked culverts are likely to be bypassed without significant increases in upstream flood water levels. The scale of the Mega Ditch is such that there is unlikely to be any significant ponding around the Proposed Scheme on the downstream side even in the event of blockage or failure of hydraulic structures.

Residual flood risks from surface water and minor watercourses

9.2.6 All culverts within the Proposed Scheme are designed with a minimum internal headroom of 600mm above the design flood water level to minimise the risk of blockage. There is therefore not expected to be any significant increased risk of flooding at minor watercourses and dry valley crossings arising from potential blockage of new culverts. In all cases within CFA12 where existing culverts are being extended the Proposed Scheme is raised at least 1m above surrounding ground and it is unlikely, due to the small catchment sizes involved, that water levels will rise sufficiently to pose a significant risk of flooding to the Proposed Scheme.

9.2.7 All land drainage is designed to convey the full design flow without reference to upstream flow restrictions. Failure of existing upstream infrastructure could result in higher flood peaks than those calculated. At all locations, however, the Proposed Scheme is at least 1m above the existing ground levels and any residual risk to the Proposed Scheme will therefore be negligible.

9.2.8 The Tetchwick Brook is crossed by Quainton Road downstream of the Proposed Scheme and a residual risk of flooding would exist in the event of blockage of the culvert beneath the road. Quainton Road, however, is to be realigned under the Proposed Scheme with design standards sufficient to minimise the risk of blockage as noted previously. Replacement floodplain storage is also provided in this location.

9.2.9 There are downstream structures present on the Doddershall Brook and Lee Wood Farm Ditch. A footpath crosses the Doddershall Brook approximately 200m downstream of the Proposed Scheme. The footpath is not significantly raised above surrounding ground and floodwaters would be expected to bypass the culvert in the event of a blockage without any significant increase in the risk of flooding upstream.

At the Lee Wood Farm Ditch the watercourse passes beneath a dismantled railway embankment. The embankment is at a level of approximately 82m AOD. Should the culvert become completely blocked the maximum level that floodwaters could reach would be 82m AOD. The Proposed Scheme would be at a minimum level of 84.6m AOD and will therefore not be at significant risk of flooding in this event.

Residual flood risks from groundwater

9.2.10 There are no significant residual risks arising from groundwater.

Residual flood risks from drainage systems

9.2.11 Blockage of underground surface water collections systems can cause surcharge and associated flooding. There are no risks of flooding to the Proposed Scheme from drainage systems associated with existing infrastructure within the study area.

Residual flood risks from artificial and surface water bodies

9.2.12 There is no significant risk of flooding from artificial or surface water bodies to the Proposed Scheme or nearby land therefore no residual risks arise.

9.3 Residual effects of the Proposed Scheme on flood risk

9.3.1 Following mitigation for impacts on the risk of flooding arising from the Proposed Scheme there will be changes to geometry, floodplain flow characteristics and river and floodplain morphology at the River Ray and Muxwell Brook. Such effects will be limited to the reshaping of floodplain extents arising from replacement floodplain storage and channel works with no overall residual effects on third party receptors.

9.4 Compliance with local planning policy

9.4.1 The Proposed Scheme includes an allowance for future increases in the risk of flooding as a result of climate change by adding a 20% increase to design river flows and a 30% increase to rainfall intensities and flows in minor watercourses as recommended in the NPPF Technical Guidance document. SuDS, in the form of balancing ponds and swales and the creation of open channel land drainage, are used throughout the design. The Proposed Scheme will be in compliance with the BuCC LFRMS. Collected surface water will discharge directly to local watercourses in accordance with the Aylesbury Vale Water Cycle Strategy.

9.4.2 Although not in direct contravention of the Thames region CFMP the introduction of additional culverts is at variance with the general aims of the Thames region CFMP which seeks to restore culverted watercourses and enhance natural floodplain. In addition, the AVDC SFRA stipulates that proposed infrastructure should avoid interference with floodplain flows and storage unless designed specifically with a flood risk management function incorporated. As part of the Proposed Scheme mitigation in the form of replacement floodplain storage will be provided where losses in natural storage capacity are identified. Although minimised wherever possible there is no practical way to avoid culverting and floodplain or valley flow obstruction due to the linear nature of the Proposed Scheme.

9.4.3 The incorporation of allowances for climate change in the design of the Proposed Scheme ensures compliance with the Vale of Aylesbury Plan Objective 7. A number of watercourses will, however, be culverted resulting in potential losses in watercourse quality and natural floodplain storage which is contrary to the overall aims of Objective 7 and Policy VS11. Further details on water quality are contained within the water resources assessment (Volume 5: Appendix WR-002-012) and the Water Framework Directive Compliance Assessment contained within the route-wide water resources appendix (Volume 5: Appendix WR-001-000).

10 References

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